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NOVEMBER'S THEME: Research and Development Laboratories (Tech Transfer)

DWIGHT'S NOTES

I've been a technology transfer advocate for a good portion of my career in the Corps…. perhaps because it is such a challenge that it has taken me a long time to learn anything about it. The Corps has steadily built its reputation with the public because of its ability to bring technology to bear to solve the nation's infrastructure problems. The nation's infrastructure needs are as great today as they have ever been. Our continued leadership meeting these challenges hinges on our ability to evaluate and incorporate new technology into our projects.

The Corps laboratories are perhaps the most substantial research and development capability in the American design and construction industry today. I'm very pleased with the response we have in this issue from our R&D community. It remains for us, the designers and constructors, to seize the opportunities these technologies provide. We are also obligated to work very closely with our laboratories, with professional societies and industry, and others to identify the future technological needs that our laboratories should begin to address today. I encourage you to set aside quality time to work with our labs on identifying long-term technological issues and to help them test, evaluate, and transfer products newly available to us.

Please use E&C in the headquarters as a resource in this regard. One of our most important missions is to provide guidance, tools, and capabilities to help you perform your missions better. We have strong champions for research and development in each of our areas of competency. Some of our people lead national technology teams to bring the R&D and user communities together. I need your encouragement and insights to do this well. Thanks to Ed Link and our labs for making this a successful issue. Thanks in advance to you for helping them make a difference for our customers and sponsors.

CHARLIE'S NOTES

The Chief of Engineers has asked me to serve as the Acting Chief, Engineering and Construction Division in addition to my regular duties as Chief, Operations Division. I am looking forward to this special assignment and especially to interacting with all of you at the district and division levels. I will continue the work that Carl Enson started as the Corps Account Executive for the Department of Agriculture and the Federal Emergency Management Agency. Both of these organizations play an important part in our current and future missions.

CHARLIE'S NOTES (CONTINUED)

This is an exciting time to be at Headquarters, I can not recall a time in my career when either the opportunity for change or the necessity for change has been so great. Consequently, we are presented with many opportunities to influence the "Corps" of the future. Each of us has that opportunity and even a responsibility to contribute and participate in developing our direction. I look forward to hearing your ideas on how we can continue to be "The world's premier engineering organization!" I would like to give all of you an invitation when in Washington to stop in and see us. We need to know what is on your mind and most importantly what are your good ideas to move our organization forward. I can be contacted by telephone (202) 761-0196 or by E-mail, Charles.M.Hess@usace.army.mil.

(Editors' note: If you want to share your thoughts with our readers regarding Charlie's or Dwight's Notes send an email to the E&C News editors (charles.pearre@usace.army.mil or denise.massihi@usace.army.mil). We'll publish a synopsis of your comments next time).

ARTICLES

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Research and Development Laboratories (Tech Transfer)

OVERVIEW: CORPS R&D IN THE NEW MILLENNIUM

The Corps has positioned itself to better meet the research and development needs of the Army and the Nation in the 21st century with the activation of the US Army Engineer Research and Development Center (ERDC).

Just as the rest of the Corps is re-shaping itself to better fit the future business environment, the Corps' R&D laboratories have been involved in a considerable re-engineering effort to better serve the Corps and Army's technology needs in the future. These changes have been designed to allow more flexibility in teaming, greater focus of resources and better alignment with the strategic directions of the Corps and the Army.

In an innovative "distributed command" concept, the Corps' eight unique R&D laboratories have been brought into a single but dispersed command headquartered in Vicksburg, Miss. COL Robin R. Cababa is the commander of the new organization. The ERDC functions as a Major Support Command and can bring a wide variety of engineering expertise and unique facilities to bear on solving a broad range of civil and environmental engineering problems.

The Corps proactive approach to shaping its own R&D future meets DOD reform mandates and provides "one door" to the Corps' R&D community. LTG Ballard authorized the ERDC through Permanent Order No. 43-3 dated 1 October 1998.

The major end objectives are:

- Deliver new technology needed to achieve the USACE strategic vision,
- Increase the relevance of the Corps to its customers,
- Increase the focus on priority future operational capabilities,
- Comply with DOD and Army RDTE Defense Reform Initiatives, and
- Sustain world-class research capability in critical mission areas.

Business Functions Realigned – In FY 99 the support functions were realigned to operate across laboratory lines as a dispersed team. While the ERDC headquarters is located in Vicksburg, the support function chiefs are located at the various ERDC sites in Hanover, NH, Champaign, Ill., Alexandria, Va. and Vicksburg. This consolidation allowed for the adoption of best business practices

from the individual laboratories and their application across the new organization. The results will save both money and manpower.

Technical Organization Re-Engineered – On 1 October 1999, in ceremonies presided over by MG Fuhrman in Vicksburg, the ERDC was officially activated and the technical functions were included in the new organization. Now research teams can be assembled which include the best people and equipment from across the ERDC to address mission requirements. This will result in savings in manpower and money and will eliminate duplication of effort and resources.

The eight unique R&D laboratories are:

- Coastal and Hydraulics Laboratory (Vicksburg, Miss.)
- Geotechnical Laboratory (Vicksburg, Miss.)
- Structures Laboratory (Vicksburg, Miss.)
- Topographic Engineering Center (Alexandria, VA.)
- Cold Regions Research and Engineering Laboratory (Hanover, NH)
- Environmental Laboratory (Vicksburg, Miss.)
- Construction Engineering Research Laboratory (Champaign, Ill.)
- Information Technology Laboratory (Vicksburg, Miss.)

Dr. Lewis "Ed" Link is the Acting Director of the ERDC. The Director will be stationed in the Washington, D.C. area.

World-Class Organization – The ERDC provides the Corps with a premier R&D organization of 2,330 team members, many who have international reputations in various fields of science and engineering. Of the 1,250 ERDC scientists and engineers over 300 hold doctorate degrees. Integrated teams of world-renowned scientists and engineers can now be assembled from across the ERDC to address a broad spectrum of problems and issues of interest to the Army and the Department of Defense.

State-of-the-Art Facilities – The combining of the resources of the eight laboratories at the four laboratory locations resulted in over $1.2 billion in research facilities and equipment being available to support all mission areas. Unique and significant R&D resources available to the entire ERDC organization includes: the world's largest and most powerful research centrifuge, a heavy vehicle simulator which can reproduce aircraft landings, one of the world's ten largest super-computing centers, ice engineering research facilities which can reproduce the effects of ice and snow, a powerful hydraulically controlled shake-table which can reproduce earthquake effects, and some of the most advanced and comprehensive environmental chemistry facilities in the world today.

Corps Vision – The ERDC initiative postures USACE to meet future R&D challenges while delivering needed products and capabilities to customers at the best value today. The ERDC demonstrates the USACE Strategic Vision: Revolutionize Effectiveness – Invest in People – Seek Growth Opportunities.

Corps R&D and Engineering & Construction – Several examples of Corps R&D projects/programs are included in this issue of E&C News which show some of the ways the R&D function supports and adds value to the Corps' engineering and construction mission. The ERDC $450 million program of work includes thousands of research projects, both civil and military. Included are a few examples of

work, which are directly relevant to the E&C mission. Much of the ERDC's R&D effort relates to and enhances E&C work. Geo-spatial, materials, CADD/GIS and environmental research are examples of other work with bearing on the E&C programs.

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INNOVATIONS FOR NAVIGATION PROJECTS R&D PROGRAM

The U.S. inland waterways navigation system provides a vital transportation resource that is recognized as an efficient means of moving a number of commodities, particularly coal and grain. However, this efficiency is diminishing in certain portions of inland waterways because the capacity of some navigation structures is insufficient to meet the current needs of the barge industry.

Available funding levels are insufficient to meet projected needs. To address this issue, a Corps of Engineers task force was created in 1992 to **e**xamine how navigation structures were being built. The task force investigated various new technologies and methods, such as in-the-wet construction, for reducing the cost of construction.

The task force evaluated 11 projects scheduled to be built at a cost of approximately $9 billion and estimated that using in-the-wet construction techniques would save $1.4 to $1.8 billion**,** primarily as a result of eliminating the need for a cofferdam during construction. The task force was also able to show that use of innovative construction techniques would result in less disruption to river traffic.

The task force study led to further investigations by the Corps and to establishment of a research and development (R&D) program—the Innovations for Navigation Projects (INP) R&D Program. Since in-the-wet construction is a new venture for the Corps, research is needed to adapt existing technologies and develop new technologies for this type of construction. The INP Program is a multi-discipline, multi-laboratory effort and has required significant coordination among the organizations performing the R&D. To accomplish this level of coordination, the INP Program has implemented a Quality Assurance Plan that requires a quarterly progress report from each principal investigator. In addition, interaction with the Inland Navigation R&D Program has been initiated to ensure that any overlaps between the two programs are identified and efforts by researchers are not duplicated.

The primary objective of INP research efforts is to identify technologies and methods that will reduce construction costs and time. The secondary objective is to minimize any disturbance that construction may have on navigation of the waterway and to the environment.

Sixteen work units have been established under the INP Program to investigate a variety of topics. Research areas include underwater concrete, lightweight concrete, filling and emptying systems, pre- and post-tensioned structures, thin-wall concrete panels, positioning measurement for in-the-wet construction, underwater foundation preparation, equipment requirements, operating controls, modular connections, contracting methods, quantifying of risks and uncertainties, and barge impacts.

These work units will be developing procedures, methods, specifications, and guidance for use by engineers in designing innovative navigation structures. In some cases, the products of the research will increase the level of confidence in the innovative methods used. Other products will help to further reduce costs. For example, the work unit on underwater concrete is developing a specification for antiwashout concrete mixtures that will be used by design engineers. The barge impact work unit

has undertaken actual barge impact tests and will perform numerical studies to help minimize impact loads and, in turn, reduce the structural requirements and related costs.

The INP Program recently completed its second year and is scheduled to continue for at least two more years. During this time, many of the current work units will conclude their work and new work units will be developed based on needs identified by engineers in Corps' district offices. Some of these needs include innovative fendering systems, analysis of multiple-anchor walls, use of equipment for positioning float-in structures, and improvements to the design process for these types of structures.

One work unit is specifically aimed at evaluating new or adapted technologies in the field. These field evaluations allow researchers to observe actual behaviors of a method or technology before it is implemented in a project and to make adjustments based on these observations. To date, field evaluations have investigated the use of GPS for placement of structural units, placement of high-performance underwater concrete, and the performance of sidescan sonar systems in evaluating placement of underwater structures. Future field evaluation projects include data collection for a pile-driving project, further studies on underwater concrete, and a barge-crushing experiment.

An important goal of the INP Program is to ensure that technology is rapidly transferred to Corps field offices that are in the process of designing innovative projects. To facilitate rapid technology transfer, a Web page has been established for the program at http://www.wes.army.mil/SL/INP/inp.htm. Available online information includes summaries of the INP work units, points of contact, published reports, announcements concerning upcoming program events, and information on field evaluation projects. To date, two technical reports have been published, and five are under review for publication in the near future.

The INP Program is playing an important role in developing techniques, procedures, and methods for implementing in-the-wet construction techniques for navigation projects on our inland waterways. The program makes every effort to ensure that its products are timely and relevant to the needs and concerns of engineers in Corps district offices. Through continued coordination and interaction between investigators and design engineers, the INP Program can provide needed information to build cost-effective, safe navigation structures on the inland waterways.

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Fiber-Reinforced Polymeric Materials for Civil and Military Construction

Fiber-reinforced polymeric (FRP) composites are gaining widespread acceptance as a viable alternative to traditional materials in new construction as well as in repair. The low density, high strength, corrosion resistance, and tailorability common to many types of FRP materials make them attractive for a variety of structural applications. Given these advantages, researchers at the Structures Laboratory (SL) of the U.S. Army Engineer Research and Development Center (ERDC) have been exploring opportunities to exploit these advanced materials for both civilian and military efforts. Current areas of research include:

Rapid Strengthening of Bridges - The effectiveness of externally bonded FRP materials to strengthen reinforced concrete bridges has been repeatedly demonstrated in the civilian market. One focus of this research program is to adapt this technology for use in military operations. To be effective in a rapid retrofit scenario, the FRP application must be both simple and robust, given the wide range of environmental conditions that an Army task force can encounter in the field. Working with personnel

from the U.S. Military Academy, SL is developing techniques to reduce total application time from days to hours. These techniques include the use of rapid-setting adhesive systems with minimal surface preparation in a variety of environments. In addition, the viability of mechanical anchorage to bond FRP materials to parent concrete is being explored. The results of this program will be incorporated into the Army's Intelligent Bridge Assessment, Repair, and Retrofit expert system (IBARR).

Repair of Hydraulic Structures – We are also investigating the effectiveness of externally bonded FRP materials for the repair and strengthening of reinforced concrete hydraulic structures. The Corps of Engineers owns a variety of these structures, many of which are under-reinforced, deteriorated, or functionally obsolete. The durability of advanced FRP materials is being evaluated in the types of severe exposures commonly seen by navigation structures. Products from this effort will include field guidance in the selection, specification, design and performance of FRP repair systems for reinforced concrete hydraulic structures. This research is being performed as a collaborative effort of the ERDC, involving participation by the SL, the Construction Engineering Research Laboratory, and the Cold Regions Research and Engineering Laboratory.

Protective Construction – The high strength and relative stiffness of many FRP materials make them promising candidates to enhance the survivability of permanent hardened facilities subjected to current and future weapon threats. Research efforts are currently underway to analyze the response of FRP materials to these unique load regimes. The applicability of these materials is being investigated, both as retrofits for existing structures and in new construction. A particular area of interest concerns the use of advanced FRP materials with high-strength concrete. Analytical and numerical studies will be combined with data gathered from laboratory tests and field experimentation to provide design guidance for the use of these advanced materials to mitigate weapons effects.

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High-Performance Concrete for Civil and Military Construction

Concrete has been an integral part of construction for centuries, yet engineers and designers often think of concrete with a "one size fits all" attitude. Progress in recent decades has brought about exciting innovations in concrete technology, which make new opportunities in the way we think of and use concrete. These advanced concrete's are called high-performance concrete's. A high-performance concrete can be defined as concrete meeting special performance requirements, which cannot always be achieved routinely using only conventional constituents, and normal mixing, placing, and curing procedures. The keys to production of high-performance concrete are (1) proper selection of constituent materials, (2) proper mixing, (3) proper placing techniques, and (4) proper curing techniques.

There are many special performance requirements that can only be met by the use of high-performance concrete. In today's highly competitive business environment, high-performance concrete that can be more easily placed and consolidated, especially in difficult placing environments, can potentially benefit its user by requiring less labor to complete the placement. High-performance concrete's can be produced that will be easier to consolidate in areas of heavily congested reinforcing steel, or be self-leveling without segregation in areas difficult to access. More efficient placements can result in cost savings while maintaining high quality for the owner.

High-performance concrete's can be produced with extended working times. This is especially beneficial for hot weather placements. Retarding admixtures are available that can maintain desired

unhardened concrete properties during long transportation times while minimizing excessive retardation after placement. For cold-weather placements, accelerating admixtures are available that will protect concrete immediately after placement down to 0 °C (32 °F). Underwater placements can be one of the most high-risk placements for concrete. During and after placement, the concrete is exposed to water which tries to wash the cementitious paste away from the aggregate in the unhardened concrete. Antiwashout admixtures provide an extra measure of cohesiveness to a concrete mixture, making the mixtures more resistant to washout as well as enhancing the concrete's flowing characteristics. Technological developments, especially in chemical admixtures and to a lesser degree in placing equipment and techniques, have made underwater concrete placements feasible in situations that could not have been considered as recently as 20 years ago. The Pittsburgh and Louisville Districts are each currently constructing a lock and dam that will use underwater concrete as an integral part of the structure.

The use of high-strength concrete sometimes allows use of fewer and smaller reinforced concrete members. The more efficient design often results in more usable working area. High-strength concrete often has increased durability as well. One innovative use of concrete in excess of 200 MPa (29,000 psi) is a pedestrian bridge constructed in Sherbrooke, Canada. The entire bridge was constructed of only the steel-fiber-reinforced concrete mixture without any conventional reinforcing steel.

Whether your need is for higher strengths, suitability for difficult placing environments, extra durability for severe environments, or even energy absorption to capture a bullet, high-performance concrete can be tailored to fit your performance requirements.

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Model Diversity Is Key to Impact Assessment on Upper Mississippi and Illinois Waterway Environmental Study

As part of the Upper Mississippi River-Illinois Waterway System navigation Study (UMRS), the Corps of Engineers has been tasked to evaluate the feasibility of navigation improvements to reduce delays to commercial navigation traffic while maintaining the social and environmental integrity of the river system. The Environmental Impact Statement (EIS) accompanying the feasibility report will consider, among other issues, the system-wide impacts of navigation capacity increases based on results from a number of technical studies conducted over the six-year study period. To evaluate biological responses to physical effects and broadcast those effects to a system of 37 locks and 1200 miles of navigable waterway required various levels of modeling and field studies that lead to the development and integration of impact assessment tools.

A suite of models, rules, and resources was necessary to predict everything from micro-level responses to macro- or system-level impacts. Studies conducted to develop these tools included detailed laboratory experiments, field studies, numerical and physical model studies at site-specific locations, and finally, screening and analytical approaches at the system-wide level. Impact assessment tools fell into three basic categories: a geographical information system (GIS), biological response models, and physical effect tools. The biological and physical effect tools, along with economic projections of traffic characteristics and frequency, were used to assess impacts on fisheries, mussels, aquatic plants and backwater/side channel sedimentation.

The cornerstone to understanding ecological impacts due to incremental increases in traffic was the thorough understanding of the physical effects produced by a moving vessel. The physical effect studies were designed to quantify the hydrodynamic disturbances both near the vessel and in areas adjacent to the channel, and evaluate these effects on sediment resuspension and transport. Biological studies were planned and executed to develop response and impact models that appropriately reflected the unique physical characteristics associated with these hydrodynamics and the projected traffic conditions.

In order to step through the many economic scenarios, apply a risk-based approach, and quantify and evaluate impacts over the large spatial extent of the study, study components were carefully integrated into system models. A multi-disciplinary team of Corps and contract employees executed the integration process. Integration of model results was necessary to facilitate exchange of inputs/outputs, develop empirical coefficients, establish extrapolation rules and verify modeling methodologies. Some of the major tools used and products developed from this study include:

Navigation Effects Flume – A research flume was built, 400 ft long by 125 ft wide equipped with a towing carriage to study the hydrodynamic effects of a moving vessel. Experiments in the flume were validated against field measurements and used to evaluate physical effects at site specific reaches in the UMRS, validate numerical approaches, and develop near-field algorithms for shear stress and propeller jet velocities.

NAVEFF – An analytical approach culminating from the results of physical effect studies in the Navigation Effects Flume, literature, and numerical results that quantifies main channel physical effects on a cross-section by cross-section analysis. This program calculates drawdown, return current, shear stress, wave height, and scour depth at a given cross-section for any given set of traffic characteristics or ambient river conditions. Outputs feed into other sediment and biological system models.

HIVEL w/ boat – A two-dimensional depth-averaged flow model that determines velocity and water level changes as a result of tow passage through selected reaches of the UMRS. HIVEL allows evaluation of complex reaches, including backwaters and side channels, which can not be evaluated using the one-dimensional NAVEFF approach.

STUDH w/ Boat – A two dimensional depth-averaged flow and sediment model used to determine sediment resuspension and lateral movement on site specific reaches of the UMRS. Velocity and water level changes from the HIVEL model were input into the STUDH model to simulate the physical forces from the tow and produce the sediment resuspension from the tow.

NAVSED – A one dimensional sediment model used to evaluate sediment resuspension for a wide range of tow types, stages, and sailing line positions as part of the system evaluation. Algorithms in NAVSED address resuspension from propeller jets, waves and velocity changes between the tow and the shoreline. NAVSED incorporated physical model and STUDH results to define outputs.

BACKSED – An analytical model to determine the quantity of tow-induced sediment resuspended in the main channel that could potentially move into backwaters and side channels. Model input was the geometry of the backwater or side channel inlet, amount of ambient flow, sediment type in the GIS, drawdown from the NAVEFF model, and sediment concentration from the NAVSED model.

Fish Spawning (biological) – An analytical model that characterizes how tow-induced changes in velocity and substrate scour determined from the NAVEFF model alter the quality and quantity of fish spawning habitat for selected species.

Larval Fish Proportional Mortality Model (biological) – An analytical model that uses estimates of larval density in the UMRS along with experimental results where larval fish mortality through a test propeller was measured, to estimate larval fish entrapment in propeller jets. Larval mortality estimates are used in the proportional mortality model to extrapolate to the abundance of selected species for different tow traffic scenarios.

Bioenergetics Mussel Model (biological) – An analytical approach using suspended sediment concentrations from the NAVSED model to estimate the dynamics of growth and reproduction of representative mussel species on the UMRS for various levels of traffic.

Plant Growth Model (biological) – An analytical approach using suspended sediment concentrations from the NAVSED model to estimate reduction of available light and the resulting potential impacts on growth and reproduction of two species of submerged aquatic vegetation.

All impact assessments and results have been quantified in a risk-based framework in which uncertainties of results are evaluated. The GIS was essential in technology transfer providing for spatial integration of modeling results, storing/retrieving data, identifying relational information between coverage's, and delivering products to the study managers.

The EIS is scheduled for completion in June 2000. Information regarding the status and results of the navigation study can be found at http://www.mvr.usace.army.mil/pdw/nav_study.htm/.

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Sediment Budget Analysis System (SBAS) Applied in Florida, Alabama, and New York

Sediment management at ports, harbors, and inlets is complex because of conflicting requirements to maintain a navigable waterway in a dynamic hydrodynamic regime while minimizing rehandling of material and adverse impacts to adjacent lands. The sediment-management problem is heightened for coastal and other inter-connected waterway systems in balancing uses of adjacent ports, harbors, inlets, and adjoining lands that may have conflicting navigation and sediment management requirements. These projects must be planned and monitored on a regional scale because moving water and sediment do not recognize project and legal boundaries.

Research and development at the U.S. Army Engineer Research and Development Center has been directed towards improving the U.S. Army Corps of Engineers' capabilities for comprehending and optimizing coastal inlet, harbor, and port sediment management. As a response, a PC-based Sediment Budget Analysis System (SBAS) was recently developed to document existing sediment-management practices, and to provide a uniform platform from which to forecast consequences of planned changes to existing procedures. The system has been applied on a regional scale, covering hundreds of kilometers and including several managed inlet systems and a range of engineering activities on adjacent lands and within the waterway systems.

Regional sediment budgets have been prepared by the U.S. Army Corps of Engineers using SBAS for the South Shore of Long Island, the east coast of Florida, and the Florida panhandle spanning the states of Florida and Alabama. These sediment budgets have spanned from 80 to hundreds of kilometers, including from three to more than 20 inlet and bay systems. Multiple beach fill and dredging events are included and documented within each SBAS application.

Sediment Budget for Shinnecock Inlet, Long Island, New York

Version 1.0 of the SBAS was released to Army Corps of Engineers users, academic institutions, and private consulting firms in June 1999. The system aids the user in developing a coastal sediment budget, which is defined as accounting of gains and losses to coastal and inlet waterway systems. Selected features of SBAS are:

- Organizes large and complex data sets.
- Automatically generates and updates sediment-budget equations as the user defines computational cells and transport pathways with the SBAS toolbar menu.
- Can include historical data, engineering activities, and conceptual models of sediment pathways at inlet, port, and harbor entrances.
- Is visually based by color coding computational cells according to their individual budgets (loss, gain, and balance) and by showing transport paths with arrows.
- Allows different sediment budgets for the same reach to be copied and modified to bracket seasonal, yearly, project-specific, and historical changes, and to reflect uncertainty and sensitivity testing.
- Can accommodate different conceptual approaches in implementing a sediment budget.
- Facilitates a regional approach and joining of independently prepared budgets on contiguous sections of the coast encompassing multiple inlets and waterways by allowing an unlimited number of cells and transport pathways, and page scrolling left and right, or up and down.

- Allows user to track uncertainty and the sediment budget imbalance within each cell and within the budget of all combined cells (the macro-budget).
- Provides capability to define dependencies of one value upon another within the sediment budget.
- Produces report-quality graphics and has all typical Windows operating system features related to graphics, cut-and-paste operations, and similar actions between software applications.
- Allows images (e.g., aerial photographs of the coast) to be loaded as background wallpaper with the sediment budget, upon which computational elements are drawn.
- Contains an on-line User's Manual, tutorial, example project, and help files.

SBAS is presently being improved to allow geo-referencing of the waterway system under study, with layers within the system to organize data, engineering activities, and other pertinent reference information that comprises the sediment budget. The U.S. Army Corps of Engineers will benefit through reduced operation and maintenance costs at Federal channels and inland waterways.

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SMART BUILDING DEMONSTRATION INITIATIVE

CERL will soon complete an implementation plan to retrofit an Army laboratory building with integrated "smart" technologies intended to improve facility performance and occupant comfort while reducing operation and maintenance costs. The smart facility concept integrates technologies such as computer automation, advanced materials, remote sensing, and energy management to improve control and performance in functional areas such as thermal comfort, lighting, environmental quality, fire safety, physical security, and electrical/mechanical systems. Smart systems will provide building managers more accurate, thorough, and timely condition information than ever before. Furthermore, smart systems will be able to conduct monitoring, inspection, and self-regulation tasks that now require direct — and often costly — human intervention.

The Rodman Materials Research Laboratory at Aberdeen Proving Ground is the selected demonstration site. To date a multidisciplinary team of CERL researchers has:

- studied the Rodman facility and interviewed personnel to identify improvement opportunities and applicable smart technologies
- conducted preliminary return-on-investment analyses to help determine the feasibility of smart technologies under consideration
- completed an advanced visualization presentation to provide DPW staff and Rodman occupants a better understanding of the proposed smart building improvements.

Expert integration of existing and retrofitted technologies will be the key to developing a world-class smart facility. The value of freestanding life safety systems such as fire detectors and chemical leak sensors, for example, could be tremendously enhanced when integrated with each other via the building's computer and communications networks. Expert integration could provide emergency personnel with accurate coordinates for a fire, to reduce response time, and might provide data on conditions at the scene (such as the presence of accelerants or hazardous materials). Communications systems could be programmed to notify appropriate DPW personnel depending on the location and nature of the alarm for a more effective response.

The most immediate cost savings should be realized in the area of energy management. The research team has determined that the operation of Rodman's current smart HVAC system could be improved

to save $270,000 per year in energy costs — a reduction of more than 30 percent off Rodman's current annual energy bill of $850,000. The Smart Building Implementation Plan, which is scheduled for completion by the end of December, will include technology adoption recommendations and system integration guidance.

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COLD-FORMED STEEL SEISMIC DESIGN

Cold-formed steel is a lightweight, versatile, and inexpensive structural material, but the Corps of Engineers has enforced a longstanding moratorium on its use in load-bearing construction due to a lack of design guidance that will lead to poor performance (i.e., non-ductile failure modes) in earthquakes. Such problems are not inherent to the material, but result from insufficient design guidance combined with specific instances of poor construction practice. However, the Army could realize significant construction cost savings if it could be determined how to design with cold-formed steel to ensure only ductile failure modes in an earthquake. To address the need for construction cost effectiveness, structural performance, and occupant safety, CERL and Omaha District developed design guidance (Technical Instruction [TI] 809-07) for the use of cold-formed steel in load-bearing applications. The document includes seismic design guidance that will ensure the required ductile system performance in a major earthquake.

TI 809-07 specifies cold-formed steel shear panels that are anchored to the building diaphragms above and below. These shear panels use diagonal steel straps as the sole lateral resisting element. The columns and connections specified are either built-up columns with self-tapping screw connections or structural tubing columns with welded connections. The guidance accounts for the very large strength variability in the material and requires significant plastic performance in shear panel diagonal straps without any brittle modes of failure in the panel columns or connections.

CERL tests of prototype shear panels in both configurations have validated an analytical model, demonstrated the effectiveness of the guidance, and quantified the hysteretic performance of this building system. The tests also demonstrated that significant panel ductility could be ensured through proper proportioning of panel members and detailing. Detailed design guidance is provided for both panel configurations.

The Air Force and Navy plan to adopt TI 809-07 in their construction, and the specification has been transferred to The American Iron and Steel Institute for promulgation in the private sector construction industry. An update to the seismic safety portion of TI 809-07 is currently under development at CERL; it will include improved connector and anchorage detailing that will be more practical and economical while ensuring ductile system performance.

TI 809-07 may be viewed and downloaded via the Huntsville Center web server (http://www.hnd.usace.army.mil/techinfo/ti/809-07/80907indx.htm). Also available via the World Wide Web is a cold-formed steel design spreadsheet program that can help engineers apply the specifications in TI 809-07. Click on http://www.cecer.army.mil/techreports/wilcfsxl.post.pdf for instructions on how to use the spreadsheet. The instructions, which require Adobe Acrobat Reader software to view, contain a hyperlink that will allow you to view the spreadsheet or download a copy to your computer.

TI 809-07, prepared by CERL, enabled the Army to safely lift its moratorium on building with low-cost cold-formed steel in seismically active regions.

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ELECTRO-OSMOTIC PULSE TECHNOLOGY FOR GROUNDWATER INTRUSION CONTROL IN CONCRETE STRUCTURES

Groundwater intrusion through a building's foundation can cause serious damage. In addition to increased concrete deterioration and accelerated rebar corrosion, basement dampness can ruin expensive electrical and mechanical equipment located in the basement space; can increase maintenance requirements through frequent repainting or cleaning to combat mold growth; and can make affected areas unusable due to poor air quality.

The usual approach to treating water intrusion problems is to "trench and drain"; excavate and expose the wall area and the base of the foundation, replace waterproofing on the wall surface, and install a drain tile system. Floors, are untreatable using conventional methods.

Electro-osmotic pulse (EOP) technology, developed jointly by researchers at the Engineer Research and Development Center — Construction Engineering Research Laboratory (ERDC—CERL) and Drytronic, Inc., of Wisconsin, offers an alternative that can mitigate water-related problems from the interior of affected areas at a cost 40 percent lower than "trench and drain."

An EOP system is established by inserting anodes into the concrete wall or floor on the inside of the structure and by placing cathodes in the soil outside the structure. The density of the anode and cathode placement is determined from an initial resistivity test of the concrete and soil. A pulsed dc power supply is connected between the anode and cathode. Figure 1 illustrates the EOP process.

The pulse sequence consists of a pulse of positive voltage (as seen from the dry side of the concrete), a pulse of negative voltage, and a period of rest when no voltage is applied. The positive voltage pulse has the longest interval; the negative pulse has the shortest interval. The positive electrical pulse causes cations (e.g., Ca++) and associated water molecules to move from the dry side towards the wet side, against the direction of flow induced by the hydraulic gradient. One of the most critical aspects of this technology is the negative voltage pulse. This allows control of the amount of moisture within the concrete, which prevents overdrying of the concrete matrix and subsequent degradation. Operating costs are similar to the expense of burning a 40-watt light bulb.

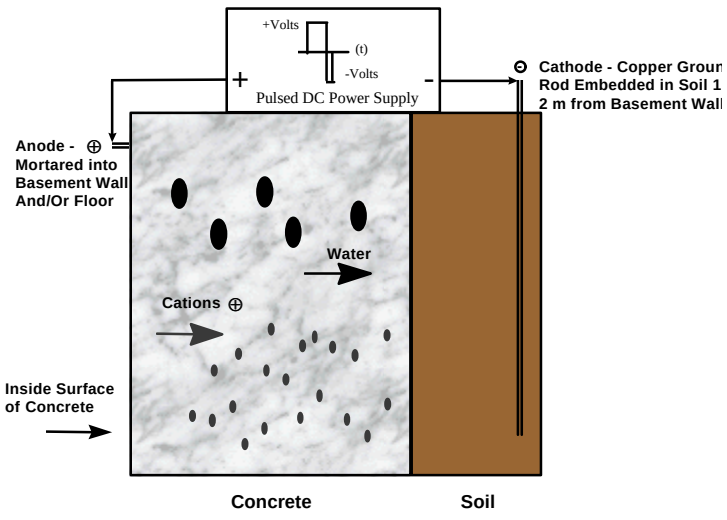

Figure 1. Cross-section of concrete and soil showing the EOP process.

The research team has demonstrated the EOP technology at a number of sites, including Fort Jackson, SC; McAlester

AAP, OK; Fort Monmouth, NJ; Tobyhanna Army Depot, PA, Aberdeen Proving Ground, MD; the U.S. Treasury Department; and the University of Wisconsin.

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PRECISE POSITIONING OF LARGE STRUCTURAL COMPONENTS

Due to increasing costs in constructing locks and dams on the inland navigation system, a Corps of Engineers Task Group was formed in September 1992 to identify new technology and methods for constructing navigation projects in a more efficient, cost-effective, and environmentally compatible manner. This team identified numerous concepts for more efficient and cost-effective construction with the potential to save between $1.4 and $1.8 billion for 11 proposed navigation projects. To implement the recommendations, the Task Group Regional Navigation Design Team (RNDT) was formed in 1994. The RNDT identified a number of innovative design concepts that promise significant potential savings over conventional techniques. This research program is a direct result of the RNDT's recognition of the need for research and development to develop procedures to use innovative concepts and develop design guidance for the Corps' unique applications. Development of innovative cost-reducing design and construction technologies will afford the construction/replacement of the needed navigation projects with the limited funds in the Inland Navigation Trust Fund. Timely completion of these navigation projects will reduce the potential for major disruptions in transiting locks and will reduce the operating costs to the inland navigation industry (U.S. Army, WES, April 1998).

The objective is to identify and develop innovative technologies and methods for the design and construction of navigation projects that will reduce construction costs and time, and will minimize the disturbance to navigation and the environment during construction. Research program focus is on technologies for Lift-in, Float-in, and In-the-wet construction. This will include designs for new filling and emptying systems for locks, the use of alternative construction methods, underwater construction with precast concrete elements, underwater control techniques, design of innovative lock walls for barge impact load, innovations for lock gate operating equipment, and contracting procedures for innovative designs and construction methods.

Global Positioning System Overview – One of the factors of the RNDT is accurate positioning of large preconstructed elements to achieve time and cost-savings. This application uses the NAVSTAR Global Positioning System (GPS), which is a satellite-based technology that enables 3-D positioning anywhere in the world at any time. The system, developed by the Department of Defense, is primarily to provide a Precise Positioning Service (PPS) to the U.S. military and its allies. GPS also provides the Standard Positioning Service (SPS), a service available to civilians with the purchase of necessary equipment. These services are enabled by the transmission from the satellites of time-coded signals unique to each satellite, and information on satellite timing and positions. By measuring the arrival time of these coded signals, a GPS receiver computes its own position on the earth's surface.

Each satellite broadcasts information through two frequencies, L1 and L2. On each frequency, coded messages (the P-code and C/A code) are modulated or carried. Both the carrier frequency and the coded messages are used to obtain positioning information. When using one GPS receiver, the 3-D absolute accuracy is approximately 16 meters for PPAS and 100 meters for SPS. (U.S. Army, 1994)

Differential GPS (DGPS) techniques process signals from two GPS receivers operating simultaneously

and determine the 3-D vector between them. When one of the receivers is established over a known location, this unit becomes a reference station and can be used to enhance the accuracy of the position of the receiver at the unknown, or rover station. This technique can be used with the code phase information transmitted by the GPS satellites to obtain meter accuracy or with the carrier information to obtain accuracy to a few millimeters. The code differential technique is commonly available in commercial receivers and has become the predominant method of positioning for hydrographic surveys in the Corps and most other agencies with such activities. Through a cooperative agreement, the Corps and the U.S. Coast Guard have established a network of permanent reference stations, based on the Coast Guard's radio beacon broadcast, along most of the nation's navigable waterways. Therefore, users need only one GPS receiver and a radio beacon receiver to achieve 1-5-meter accuracy.

In the past, the accuracy to which a moving platform could feasibly be positioned using DGPS was limited by the code differential technique. Achieving sub-meter accuracy requires using the carrier phase signal. In differential applications, this has had strict operational constraints; namely, the requirement to initialize at the reference station when beginning data collection or when a satellite signal is lot. Such dependency on reference station initialization before and during survey missions renders carrier phase techniques and, thus sub-meter positioning accuracy, were not feasible until recent surveys (U.S. Army, 1996).

Differential GPS for Large Structural Placement – New rapid modular construction techniques are being used to build and repair major navigation structures in the nation's navigation system. These methods make possible much less interruption on the navigation systems and are less costly. However, new methods of installations are required including the ability to precisely position large modular components of these structures. A recent demonstration of this ability using DGPS to place a large steel cell into lock and dam 24 was conducted at Clarksville, Mo. (Mann, 1998).

The cell was designed to be placed over 3 casings, which were positioned by standard geodetic methods using a total station-surveying instrument. The casings were set by rotary drilling approximately 10 feet into the river bottom. The purpose in the first phase of the project was to monitor the positioning of the casings and to verify that position by demonstrating the use of DGPS technology and high accuracy positioning software in placing large structures.

To monitor the position, a small diameter GPS antenna was installed on the drill string centered over the drill bit, which was approximately 50 feet above the drill floor. A second GPS antenna was installed on the drilling platform so accurate heading information could be calculated. Cables were attached at the antennas and connected to the geodetic receivers on the deck of the drilling barge. One radio antenna was connected to the two receivers to provide the real-time kinematics (RTK) corrections. These corrections are computed to give more accurate positioning. Since the survey construction crew was using a local coordinate system, we used a coordinate transformation program to convert from WGS84 to the local system. A monitor was interfaced to the computer and receiver and used software developed by Trimble Navigation Inc., to acquire and process the position data. This software, Target: Structures, consists of algorithms to compute the coordinates of the antenna and to give a graphic display of the location of the antenna. The actual position is compared to the desired position and is shown in real time.

The construction personnel can see where the structure or in this case the drill string is and maneuver to the desired location. In addition, an inclinometer was attached to the derrick for the installation of the second casing to give real-time data on the derrick orientation. These data were also displayed on

the monitor and gives a real-time display of the antenna position.

To position the cell over the casings, two GPS antennas were mounted. Once the casings were positioned, they were filled with concrete and allowed to harden. The following week, the steel cell was scheduled to be positioned. The cell measures approximately 35 feet in diameter and 45 feet in height. Inside the cell are five structural triangular frames oriented horizontally with openings to fit around the casings. This was required to secure with receivers to the side of the cell. A radio transmitter also was installed at each antenna site to transmit the position to the shore station. This equipment was mounted in steel boxes at the axis of two of the members of the triangular frames. Knowing the distance from the center of the cell and the angle between the triangular arm members of the frames (120 degrees) allowed calculation of the position of the antennas and entered those values into the software. The designed coordinates of the three casings also were entered. This provides a display of the desired final position of the steel cell. Because the same software used for the casing placement was to be used for the cell placement, no further geodetic information needed to be entered.

The cell was lowered using two cranes with a bridal attached in four places on the cell. The real-time position of the cell was recorded and transmitted to the computer on shore and displayed on the monitor.

Summary – The successful demonstration of the DGPS system for precise placement of large construction modules at lock and dam 24 is a clear example of this technology's application to large construction projects. Leveraging its use in additional rapid, efficient, cost-savings construction projects on the nation's waterways is a continuing goal of this applied research initiative.

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GROUND-SOURCE HEAT PUMPS

Ground-source heat pump (GSHP) technology has gained widespread acceptance in the private sector in recent years. A number of military bases have installed systems and, due to their success and the general growth of the concept in the private sector, more opportunities are being discovered within DOD. The largest application to date in the military has been at Ft. Polk, LA where all 4003 family

housing units were retrofitted with GSHP systems under a shared energy saving contract. Electric energy consumption in the family housing area was reduced by one third and peak summertime electrical demand was reduced by more than 40%.

GSHP systems use the ground as a heat source during the heating season and as a place to reject heat in the cooling season. GSHP achieve efficiency improvements over air source heat pumps because the ground is a better heat source or heat sink than air since its temperature is relatively stable. Some systems use groundwater, where available, as the heat source/sink, while others use various methods for thermally connecting or "coupling" the heat pump system with the ground.

Vertical ground-coupled is the most common type of GSHP system and is probably the most appropriate system for Army installations. Vertical U-tubes of high-density polyethylene piping are placed in boreholes and are manifolded in shallow trenches near the surface. Vertical ground-coupling systems have several advantages: low land area requirements, stable deep soil temperatures with high potential for heat exchange with groundwater, and adaptability to most sites. Among vertical ground-coupling's disadvantages are potentially higher cost, problems in some geological formations, and the need for an experienced driller/installer.

Groundwater makes an excellent heat source/sink for heat pump systems. For larger scale systems where sufficient quantities of groundwater of adequate quality are available, a groundwater system will often be the least expensive GSHP system. These systems benefit from a stable source temperature and have a longer history than other types of GSHP systems. The disadvantages of groundwater based systems are environmental regulatory requirements, potential problems where water quality is poor, and their site-specific nature.

Advantages of GSHP systems include low operating costs, low maintenance costs, ideal multizone comfort with simple control systems, high reliability, reduced or eliminated mechanical-room space requirements, and no fuel burning or fuel storage requirements. The primary disadvantage of GSHPs is that they tend to have higher initial costs than some conventional systems, especially in family housing applications. In larger multizone buildings, however, they are able to compete favorably on a first-cost basis against some of the more costly conventional systems.

In some regions, the lack of GSHP infrastructure can be an additional disadvantage. In areas where GSHPs have not seen much development, it may be difficult to locate experienced designers and installers, but it is often possible to procure these services from outside the area at competitive prices.

The Engineer Research and Development Center's Cold Regions Research and Engineering Laboratory (CRREL) has conducted a number of research and demonstration projects on GSHP technology. With the lessons learned from these projects and the help of the leading design authorities in the US, CRREL has conducted three short courses for designers on GSHP systems. Two more are being offered in November/December 1999 and we hope to be able to offer additional courses in the future, email gephet@crrel.usace.army.mil if you are interested.

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DAM LESSONS LEARNED FROM MAJOR EARTHQUAKES THIS YEAR

Four major earthquakes occurred on planet earth from August to October 1999 hitting Turkey, Taiwan, Mexico and California. These events provided the Corps and other earthquake engineers and scientists with new technical insights. For the earthquakes in Turkey and Taiwan, ERDC sent researchers within days of the event to observe performance and failure mechanisms for dams, hydropower facilities, landslides and buildings. In August, three researchers went to investigate the effect of the Izmit earthquake (local magnitude 7.4) in Turkey. In September, five went to Taiwan to evaluate the effects of the Chi Chi earthquake (local magnitude 7.3).

A field log was posted on the team's web-site and updated nightly, when phone connections could be made, for the Chi Chi, Taiwan earthquake trip. Web-posting served two purposes: a) to allow engineers and scientists around the world to see the earthquake effects in almost real-time; and b) to experiment, for possible future efforts, with real-time documentation that gives a new level of access to critical information for decision makers half way around the world. The team's web pages had as many of 1500 visitors per day.

It is important to quickly send researchers to earthquake areas because recovery operations start immediately and failure conditions are quickly erased. Also, expert eyes know where to look and what information is critical. Experts know how failures form, the process of failure, and which failure modes dominate. Sometimes, more can be learned from marginal failure than from total structural collapse or major ground failures since these data help define safe from unsafe strength/load combinations. Knowing where to concentrate limited time in the field is also crucial.

A number of important geotechnical observations can be summarized from these two special field studies. The first observation from the Izmit earthquake is that liquefaction of silts can cause massive foundation bearing failures and settlement. This observation is important for earth dams and other structures founded weak, silty soil deposits. There are numerous case histories of ground and structural failures caused by liquefaction of clean and silty sands. However, massive building foundation failures in the city of Adapazari were unique cases for liquefaction of silts and sand-silt-clay soil mixtures. These buildings either rotated (as much a 50 degrees) or sank (to a depth as great as 2 meters) because the foundation soil liquefied which reduced the strengths to levels lower than required for bearing loads.

The profession understands that earthquakes can generate high pore pressures (a prelude to liquefaction) in silts and soil mixtures but many engineers did not believe that large-scale failures were possible. These massive building foundation bearing failures should be a wakeup call for major structures. Weak foundations can lose strength causing bearing capacity failures, settlement, spreading, sliding, tilting and/or translation of the structure.

Another geotechnical observation is that properly engineered and constructed earth dams performed extremely well, even when subjected to high acceleration within close proximity of major fault rupture. Four earth/rock dams were inspected in Turkey and all performed well. Kirazdere Dam in Izmit, Turkey is a recently built, 108m-high earth/rock dam founded on rock. This dam was located practically at the epicenter and experienced seismic shaking of about 0.4 g and had no apparent damage.

This is also the case for a number of dams in Taiwan that were severely tested by the Chi Chi earthquake. Only Shi-Kang Dam failed, not so much from strong shaking but from fault offset. This was a gated concrete gravity dam constructed right over the thrust fault. Recently, a web-surfer saw the Taiwan pictures and reported that Shi Kang Dam had a section of the dam drop down due to fault movement. The real story is that about three-quarters of the dam and most of the reservoir were lifted up by the hanging wall of the thrust fault – a completely different mechanism, with completely different consequences, such as loss of storage capacity in the reservoir and upstream flooding.

Shui-Shih Dam and Toulih Dam, both zoned, earth and rockfill dams, were shaken by ground motions near 1g (horizontal and vertical), and performed very well. These two dams retain Sun-Moon Lake, the primary upland storage for hydropower in central Taiwan. Both dams were constructed by the Japanese circa 1941. These dams experienced some cracking and settlement, but showed no signs of leakage or loss of integrity to retain the reservoir.

A massive landslide dam at Tsao-Ling was formed by several slides into the river valley during the Chi Chi earthquake. The inter-bedded sandstone and clay shale of the mountains in this area have particularly unstable geometry. This location has experienced at least four large landslides in the past, three caused by earthquakes and one caused by rainfall. A block of material about 200 m tall, 200 m wide, and 3.5 km long remains on top of the mountain ridge, waiting to come down in a future triggering event. A reservoir is now forming behind the landslide dam, flooding upstream property. Time is ticking away as the Taiwan engineers and scientists search for a practical way to manage the drainage area, before the dam is overtopped. Failure of landslide dams typically result in downstream flooding, with sediment eroded from the dam filling downstream channels.

The dominant problem in Taiwan was fault offset, rather than strong shaking. Engineers and scientists have little practical predictive capability for fault offset. This is an area that needs more work to better protect our structures from earthquake hazards.

The ERDC Earthquake Reconnaissance Team consisted of Dr. Ghassan Al-Chaar, Dr. Moustafitz Chowdhury, Dr. Mary Ellen Hynes, Team Leader, Dr. Ellis L. Krinitzsky, and Dr. Richard S. Olsen.

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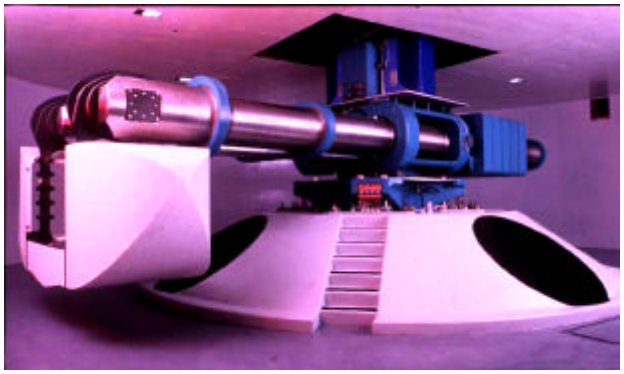
Centrifuge Research Center

The Centrifuge Research Center, located at the Waterways Experiment Station, supports the Corps of Engineers and other Federal Agencies and collaborates with industrial, commercial, academic, and international organizations to address novel and demanding engineering and scientific problems worldwide.



The centrifuge can recreate a wide range of field phenomena and environments under laboratory conditions, generating realistic data to verify and validate computer simulations and engineering analyses. Conditions imposed in the field are replicated in physical models that are subject to the full prototype self-weight stresses and strains.

The key characteristics of the Army centrifuge are as follows:

Gravity Range	=	10 to 350 g
Platform Radius	=	6.5 m
Payload at 143 g	=	8000 kg
Payload at 350 g	=	2000 kg
Centrifuge capacity	=	1144 tonnes

The Army centrifuge is unique in its range of capabilities and breadth of research applications. Primary thrusts of research are in the areas of:

- **Blast effects**
- **Embankment and levee behavior and emergency flood fighting**
- **Dredge material behavior and capping**
- **Contaminant and groundwater migration**
- **Earthquake response of earth structures**
- **Vehicle mobility and pavements**
- **Physics of frozen soils and water**
- **Hydraulic and coastal processes**
- **Soil-structure-interaction**

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Technology on the Move

The newest member of the youngest laboratory in the recently activated U.S. Army Engineer Research and Development Center (ERDC) enters the new millennium with a focus on effective technology transfer. As a premier organization in the mission areas of sensors, sensor-integrating software, electronics, and feedback-control systems, the Instrumentation Systems Development Division (ISDD) of the Information Technology Laboratory (ITL) provides support to the site laboratories, Corps of Engineers Districts and Divisions, and other government agencies. Specifically, this support includes the design, development, construction, calibration, and application of sensors and electronics; the development of interfacing software that makes the sensors' outputs available to the engineer; and the development of feedback-control systems that allow mechanical systems to be controlled by sensors. The ISDD also provides data reduction services for a variety of phenomena.

"Our biggest asset in ISDD is our very talented and dedicated staff," states Dr. Charles R. Welch, ISDD Chief and Director of SAVIAC, the Shock and Vibrations Information Analysis Center. "ISDD team members presently share 19 patents, with 10 additional patents pending." These patents include a broad range of devices. For example, one patent is for a helical optical strain fiber sensor that measures the strain in concrete during the curing cycle; a second is for a self-contained cone penetrometer that determines the shear resistance of soil as a function of depth; and a third is for a high-fidelity particle velocity gauge for ground motions very close (within a meter) of explosions.

The ISDD staff itself is composed of twenty-five electronic technicians, twenty-three of whom have associates or higher degrees, and twenty-two electronic engineers, mechanical engineers, and physicists, four of whom are Adjunct Professors and PhD's. Together they provide a broad spectrum of technical knowledge and experience across the ISDD mission areas.

The ISDD has supported numerous civil works projects for locks and dams. ISDD engineers and technicians successfully designed, constructed, and tested the automated positioning equipment for the fish deterrent system transducers at the Richard B. Russell power plant, Savannah District (Figure 1). This computer-controlled system projects a high-intensity, multiple frequency, acoustical sound field into the water on the downstream side of the dam. The computer monitors both the frequency and the sound intensity on each transducer and reports any errors back to the dam control room. In addition to the sound field, the computer monitors the lighting conditions near the dam in order to verify that sufficient lights are illuminated at all times to assure that various species of fish are lured from the dam during pump-back operation.

Figure 1. Fish deterrent instrumentation at Richard B. Russell Dam

In a rapid response to concerns for the structural integrity during watering-dewatering cycles at the Savannah District's Augusta Lock and Dam, ISDD devised an instrumentation suite to monitor displacements of the locks walls and joints (Figure 2). An underwater instrument array was installed consisting of linear displacement transducers, inclinometers, and pressure sensors. Data were continuously logged for the duration of the project.

Figure 2. Dewatering operations at Augusta Lock and Dam

ISDD engineers recently completed work on the EXPERT system for gate control at Little Rock District's David Terry Lock. This system works with the Supervisory Control and Data Acquisition and input from various "expert" sources such as rain gauges, pool heights, and other sensor data to control gate positions at the dam, and ultimately to maintain a navigable waterway under all flow conditions. This type of system has the potential to automate navigation and flood-control systems throughout the nation.

The Strong-Motion Instrumentation Program (SMIP) is designed to provide insight into the safety of, and to act as an inspection guide for, existing and future Corps structures. Additionally, it provides a measure of project performance and serves as a database for earthquake research. By the Corps' directive, ERDC is responsible for the operation of a significant portion of the SMIP instrument network. The ISDD's responsibility under this program includes reviewing instrument locations and type to assure conformance with OCE policy, evaluating new digital instruments and communications technology; processing and analyzing records and furnishing copies of the records to the associated Districts, coordinating with the Districts to establish schedules for inspection visits, and providing personnel for installation and maintenance of Corps instruments. As of October 1999, 122 projects in 31 states and the Commonwealth of Puerto Rico were instrumented. Instruments in operation as of that date were 428 accelerographs, 54 peak recording accelerographs, and 36 seismic alarm devices.

In support of the Corps' dredging mission, ISDD electronics engineers installed upgrades to the data acquisition and reporting system used for monitoring, reporting, and archiving dredge production parameters on the New Orleans District's *Dredge Wheeler*. ISDD engineers also installed an unmanned instrumentation system for monitoring production on a contractor-operated dump scow for

Figure 3. Instrument installations on a dump scow

the San Francisco District (Figure 3). This system monitors the vessel's location, measures the level of dredged material in the hopper, and transmits the dredging data over a cellular telephone data link.

ISDD engineers assisted personnel from the Coastal and Hydraulics Laboratory (CHL) with the development of the Silent Inspector system. The Silent Inspector uses a stand-alone PC to log the dredging parameters and then report the progress of the dredging to the Corps District. ISDD engineers inspected Mobile District's contractor dredging vessel for meeting the Silent Inspector criteria, developed specifications for the Contractor/Corps computer interface, modified the computer code used for Corps dredge monitoring, and reprocessed pre-existing dredging data for input into the Silent Inspector program.

The Corps of Engineers is committed to protecting the nation's infrastructure. When disaster strikes, such as an earthquake, involving structural collapse, personnel from the Corps' Urban Search and Rescue Teams are immediately deployed. Among the equipment used by these teams is the ISDD-designed Systems to Locate Survivors (STOLS) (Figure 4). The STOLS is a sophisticated "listening" system that uses highly sensitive microphones or geophones to detect the sounds made by a trapped person. ISDD has disbursed the STOLS systems throughout the Corps Districts. ISDD personnel have trained others in the operation of these systems and have participated in search and rescue missions. ISDD engineers continue to propose new ideas and pursue funding for improved STOLS designs based on recent sensor and electronic developments.

Figure 4. Mock deployment of STOLS by a Corps of Engineers District

In support of the Corps' Innovations for Navigation Research Program, ISDD engineers and technicians, together with ITL's Computer-Aided Engineering Division, recently completed a series of full-scale barge impact experiments at the old Gallipolis Lock, near Huntington, WV (Figure 5). In this series of 40 individual impact tests, a fully ballasted 15-barge tow was driven at varied angles and speeds against the lock wall. Instruments on both the barges and lock wall recorded a myriad of parameters that included impact load, acceleration, lashing loads between barges, structural strain, and hull pressure. In addition to the barge-wall collisions, a protective fendering system was deployed on the lock wall and evaluated with additional barge impact tests. As a direct result of these experiments, long-standing lock construction standards are now in revision.

For the past five decades ISDD has provided measurements of blast and shock for the explosion experiments carried out by the ERDC Structures Laboratory and other Department of Defense agencies. These experiments involve making measurements of ground shock, airblast, structural response, and water shock in blast pressure environments that can range to over 345 MPa (50,000 psi), accelerations to over 100,000 g's, and displacements up to ten meters. The ISDD has developed unique sensors, cable protection systems, electronic systems, and measurement techniques that allow measurements to be successfully made from well within the crater region of an explosion. Many of the hardware items have been patented. One of these is a very shock-hardened (to over 100,000 g's), high-speed, miniature (less than 131 cm^3 (8 $in.^3$) electronic digital data recorder and signal conditioner. The

Figure 5. Barge impact experiments

recorder rides in high-speed projectiles during weapon penetration experiments in soils, rocks, and concrete to record the deceleration of the projectiles. The recorder is recovered after the experiment and is read using a computer. The development experience associated with this recorder has allowed the ISDD to become one of the most knowledgeable groups in the United States in the development of ultra-hardened electronic circuits.

ISDD has significant experience in satellite communications (Figure 6). The ISDD staff has implemented a system that allows users at remote sites to transmit voice, data, and video. The system was assembled to support TeleEngineering activities. A TeleEngineering Operations Center was established by the ERDC under the proponency of the U.S. Army Engineer School and is being implemented as a mechanism to provide solutions to problems that exceed in-theater capability. This capability provides deployed personnel access to subject matter experts throughout the Corps. The communications system consists of an INMARSAT–B satellite terminal, a laptop computer, and a video-teleconferencing unit. The system also supports secure communications using National Security Agency (NSA) certified encryption devices. Recently, these portable systems have been used in the Balkans to support engineering efforts. The system can be powered from various sources and can be used in a vehicle. ISDD engineers indicate that the system can be easily modified to support unattended monitoring of facilities and structures. For this purpose, sensors could be used to trigger monitoring. Sensors could also be interfaced with the system to incorporate measured data with imagery.

Figure 6. INMARSAT-B satellite terminal

ISDD provides significant design, development, and implementation support to the Site Characterization and Analysis Penetrometer System (SCAPS) program, which is managed by the ERDC Environmental Laboratory. The SCAPS platform consists of a 20-ton truck (Figure 7) with onboard instrumentation designed to provide a rapid and cost-effective means to characterize soil conditions at sites undergoing installation restoration or cleanup. Under sponsorship of the Army Environmental Center (AEC), ISDD staff developed new data acquisition platforms and transitioned the new systems to the Kansas City, Tulsa, and Savannah Districts, all of which employ SCAPS. AEC also sponsored ISDD to develop and transition a

penetrometer-probe structural-failure-prevention system. The Probe Failure Prevention System monitors the stresses and strains in a penetrometer probe during soil penetrations. When the forces on the penetrometer probe exceed the predetermined threshold amount, the instrumentation system generates an alarm to notify the user that structural failure is about to occur. The system allows the user to discontinue soil testing and retract the probe from the soil before breakage occurs, thereby avoiding costly replacement of probes and/or sensor modules. Under the sponsorship of the Strategic Environmental Research and Development Program and the Environmental Security Certification Technology Program, ISDD provided support to SCAPS field activities detecting volatile organic compounds (VOCs) and metals contamination. Other ISDD research efforts have served to advance detection of VOCs and metals contamination, enhanced soil-testing capabilities, and supported development of sensor devices for the detection of anti-tank and anti-personnel mines.

Figure 7. Site characterization and analysis penetrometer system

In a promising new area, the ISDD is developing a collaborative program with the Diagnostics Instrumentation Analysis Laboratory of Mississippi State University to advance the state-of-the art in Phase Profilometry (also known as Fourier Transform Profilometry). This technique employs digital pictures of surfaces illuminated by periodic shadows to measure surface elevations. An example of a periodic shadow is the shadow caste by light coming through a window blind. Changes in the surface elevations distort the shadows. This distortion can be used to determine surface elevations through sophisticated computer processing of the digital image. Phase Profilometry has the potential for measuring pitting or cratering in concrete, wall deformations, and pavement deformations, among other things. In a recent experiment with CHL, it was used to measure water-surface waves in a hydraulic model.

Whether providing expertise in small-scale modeling, instrumentation to validate pavement response numerical models, or conducting explosive field experiments, the ISDD team has considerable expertise to accomplish the task. ISDD technology transfer efforts can be found on the ISDD web site found at www.wes.army.mil/ITL/ISD/isdd.html. This informative site contains summaries of recent projects, information about patents, technical articles, points of contact, and ISDD-developed software downloads.

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District of the Month

Editor's Note

This is the second of a series of articles highlighting the engineering and construction functions at our Corps of Engineers districts. The editors requested volunteer Districts to submit articles about their programs. To date we have sufficient volunteers to take us through the March 2001 issue of the E&C News, except for this month. The Jacksonville's article last month was about Engineering only, the

Editors asked Jacksonville to provide a Construction article for November. Districts interested in volunteering for future issues may contract one of the editors of the E&C news to place your District on the waiting list.

POC: CHARLES PEARRE, CECW-EP, 202-761-4531

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JACKSONVILLE CONSTRUCTION

Construction, Engineering Mark Success – The U.S. Army Corps of Engineers' uniform is olive green and its civil works mission is actively "greening" the Corps. The Corps' Jacksonville District constructs projects in Florida, Puerto Rico and the U.S. Virgin Islands, giving it a canvas that includes flat low-lying wetlands, white sand beaches and steep rock-faced mountains. The environment is an ideal geographical location to apply innovation to both traditional and visionary activities in the civil works arena. The types of projects and their settings are as diverse as their common goal: to provide first-class engineering products and services to customers at the least cost and in the shortest time.

Constructing and engineering the world's largest civil works project, Everglades's restoration, alone would be challenge enough for any Corps of Engineers district. With the second largest civil works program in the nation and the unique and varied demands that serving the state of Florida and the Antilles place on an organization, one can see that the Jacksonville District has construction and engineering requirements that are both challenging and diverse.

At the same time, Jacksonville must continue to provide traditional civil works services including flood control, water management, navigation, shore protection and environmental restoration.

Portugues and Bucana Rivers, Puerto Rico Flood Control Project – One major project are the Portugues and Bucana Flood Control Project. The Portugues Dam, now under construction, is a double curvature, thin-arched structure 1,500 feet in length along the crest, 270 feet high, 44 feet wide at the base and 12 feet wide at the top. One-of-a-kind grouting using microfine cement has recently been completed in rock beneath the dam as discussed in the September issue of *ASCE Civil Engineering Magazine*. It will be located 8.3 miles above the mouth of the Portugues River and will be 272 feet high. Construction will be staged in two phases. Phase one will be flood control only and Phase 2 will be shoal removal. The final reservoir will provide 24,2000 acre-feet of flood control and water supply storage. The estimated water supply yield of the Portugues is 11.1 mgd.
The value of the property subject to flood exceeds $6 million. The project involves construction of 9.1 miles of channel improves and two multi-purpose dams with uncontrolled emergency spillways. The project will provide SPF flooding protection, a dependable water supply for the city of Ponce and surrounding area, and recreational facilities on the lakes and channels.

The Cerrillos Dam is located on the Cerrillos (Upper Bucana) River, 9.5 miles above its mouth. The already constructed Cerrillos Dam is 323 feet high with a reservoir that provides 47,900 acre-feet of flood control and water supply storage. The estimated water supply yield of Cerrillos is 22.9 mgd.

Rio Puerto Nuevo Project – Another major flood control initiative is the Rio Puerto Nuevo Project in San Juan, Puerto Rico. Ongoing improvements will provide 100-year flood protection to a major portion of the San Juan metropolitan area by enlarging 11.2 miles of channel along Rio Puerto Nuevo at a cost of approximately $450 million. This project has provided some engineering challenges which were addressed using technologies such as wick drains, soil anchors, grouted concrete panels to line

sections of the finished river channel bottom from bank to bank, and driving 48-inch steel piles through the deck as part of a bridge retrofit to provide for earthquake protection.

Action Groups Provide Guidance – To help with the administration of the construction of these two projects, the District has instituted the Portugues Action Group and the Puerto Nuevo Action Group. Senior engineering, construction, project management and geotechnical representatives from Jacksonville and Puerto Rico conduct monthly meetings to identify and resolve issues on the design, implementation, funding and construction of these projects.

Kissimmee River Restoration – The terrain of central Florida has changed. Historically, the low-lying land spent much of the year under water because of seasonal rain. The gradual slope of the land allowed the water to drain slowly south to Lake Okeechobee, providing a rich habitat for fish, birds and other wildlife. The habitat was not as conducive for man's relatively recent arrival to the area. Flooding of the Kissimmee River basin destroyed crops, killed livestock, ruined businesses and destroyed homes.

As a result, the Army Corps of Engineers, on direction from Congress, dredged segments of the Kissimmee River in the 1960s to prevent seasonal inundation of the flood plain. The 100-plus mile river became a 53-mile canal. Flooding essentially ceased; new problems arose. Although the project solved flooding in the area, it contributed to detrimental effects on the environment. The Corps, with its sponsor, the South Florida Water Management District, is now working to reverse those effects. In May of 1999 major construction began on restoration of a portion of the Kissimmee River, the primary headwaters of Lake Okeechobee. In the early 1960s the Corps straightened the channel of the River as part of a major flood control initiative. Restoration calls for filling approximately 22 miles of the artificial channel, excavating nearly 12 miles of new river channel, and removing water control structures within the backfilled canal.

On and Over Waterways – The system of harbors and waterways located in the District is one of the largest in the country. The District operates and maintains approximately 60 different navigation projects, including 16 deepwater ports, 30 navigation locks and more than 2,100 miles of inland waterways.

The District is also designing and will construct a high rise precast segmental concrete girder bridge to replace an existing 80 foot span double-leaf bascule bridge over the Atlantic Intracoastal Waterway approximately 30 miles south of downtown Jacksonville, Florida. The original bridge (built in 1937) is located on a vital hurricane evacuation route and is functionally obsolete, posing a constriction to emergency evacuation of the coastal beach areas. The new replacement structure (2138 feet long and four lanes wide) maintains a 65-foot vertical clearance for navigation and provides a 290-foot clear span over the waterway. This state of the art bridge will feature the second longest clear span built in Florida using a segmental precast girder system. The approach spans are built with conventional bulb-T prestressed girders.

World's Largest Restoration Project – The $7.8 billion Central and Southern Florida Restudy Project, Everglades restoration, now before Congress will challenge all of the personnel and facilities of the district. The plan will improve the health of more than 2.4 million acres of the south Florida ecosystem to include Everglades National Park, improve the health of Lake Okeechobee, virtually eliminate damaging freshwater releases to the estuaries, improve water deliveries to Florida and Biscayne bays, improve water quality, and enhance water supply and maintain flood protection.

The District has the strong technical capabilities needed to accomplish this work. Water modeling is critical to the program's success. Con Ops will also be involved in constructing critical projects associated with Everglades's restoration. CADD, Geographical Information System capabilities, and digital terrain models have been developed for the canal and levee networks that are valuable communications tools and will enhance the construction of these works.

Con-Ops Programs Contribute to Project Success – The District's Construction-Operations Division is also engaged in a variety of "work for others" projects. These include EPA, HUD, DEA, INS, USARSO, USAR, Navy, Coast Guard, and Department of Agriculture.

By partnering during construction with sponsors, environmental organizations, local, state and other federal agencies, and other stakeholders, the District is able to ensure that all concerns are identified and resolved. Participants develop action plans that address those concerns. During quarterly meetings, the participants review the action plans, check the status of action items, and tour the construction site. "The action plans don't change the contract," said George Cooper, the District's Atlantic Coast Area Engineer, who often facilitates the partnering meetings. "But they serve as an excellent communications tool to ensure that all the parties are included in the process." The District's Office of Counsel, Engineering Division, Project Management, Construction and Contracting representatives are fully engaged in these sessions.

The District leads the Corps in CQM training. Training is conducted in Florida, Puerto Rico and the U.S. Virgin Islands. Participants include contractors, local governments, local sponsors and other interested organizations.

Construction-Operations has also instituted the "Safety Pays Program" to award government and contracted partners for their proactive safety programs. The goal of the program is to raise the safety awareness of the government and contractor partnership through a closer involvement of this alliance. By employing programs such as these before and during the construction of projects, the District can identify and correct situations that could lead to personal injury or equipment damage that often result in project delays and increased costs.

In summary, Jacksonville District enjoys an ever-changing array of complex technical and construction challenges. District leadership is meeting these challenges by providing technical and construction personnel with the training, tools and resources necessary to not only accomplish the tasks assigned but to achieve technical excellence and proudly be soldiers of the Corps' uniformed "olive green" Army.

POC: CHARLES MCGEHEE, CESAJ-CO-C, 904-232-1122

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Update

MODULAR DESIGN SYSTEM

An enhanced version of the Modular Design System (MDS) will be released during FY2000. MDS 2.1 assists design professionals during planning, design, engineering, and construction document preparation. Although it is not a replacement for the design professional, it helps the designer generate a design based on an organization's custom criteria. MDS modules capture information about commonly used space types and the design process. To use MDS, a user selects modules for desired space types, chooses an available size or dynamically "stretches" the module to an appropriate size,

and places them into a space layout. Once the preliminary design is complete, MDS converts the space layout into an initial architectural plan containing walls, room numbers and names, and predefined architectural items. Every module for a function or room contains criteria for architectural, electrical, mechanical, plumbing and furniture disciplines. The architectural palette contains tools needed to complete the architectural plan. MDS generates the other engineering discipline's initial plan with predetermined elements. Each discipline has an MDS tool palette to help complete its design effort, including cost estimates and construction documents.

MDS uses commercial off-the-shelf (COTS) software when possible and is built as an extension of Bentley System Inc.'s MicroStation CAD platform. MDS 2.1 has been enhanced to include new parametric design capabilities, the ability to export to COTS products, and compatibility with "plug and play" components such as energy analysis, export of STAAD Pro compatible structural models, and seamless integration with the TriForma HVAC duct design application. These components were acquired from technologies developed at CERL, other Corps laboratories, other Federal research efforts, and COTS software.

MDS delivers benefits and savings in several different areas. The time and effort spent to design, engineer, and prepare construction contract documents for a facility are reduced because of the model-based engineering capability within MDS. The reductions of total time required for design and engineering efforts varies depending on the specific discipline. Design and engineering errors may be significantly reduced as a result of the pre-engineering afforded by model-based engineering principles and practices.

MDS was the result of work by both Corps of Engineers employees and private sector A/E and software companies. MDS 2.1 was created by a development team consisting of the Louisville District (CELRL), the Engineer Research and Development Center (ERDC) laboratories (Construction Engineering Research Laboratory [CERL] and the Information Technology Laboratory [ITL]), and private sector partners. Bentley Systems, Inc. (vendor of building design and engineering software), Building Systems Design (cost estimating and specifications software), and JMGR (an A/E firm), participated in MDS development. Huntsville Engineering Center is also participating in data development and testing.

MDS was initially developed by the Louisville District to expedite the programming, design and construction documentation portion of the facility acquisition process. Louisville District is the Reserve Support team for the Army Reserve, and is involved in updating data and validating MDS results. While the Army Reserve and National Guard funded the initial effort to support 2 facility types, it has been successfully used in 10 other facility type charrettes.

POC's: Chenita McNeely, CEERD-IC, 601-634-4466,
Beth Brucker, CEERD-CF-N, 217-352-6511, ext 7348,
and Kirk McGraw, CEERD-CF-N, 217-352-6511, ext 7511

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CADD/GIS Bulletin

The September 1999 issue of the *CADD/GIS Bulletin*, published by the CADD/GIS Technology Center for Facilities, Infrastructure, and Environment, is now available online at http://tsc.wes.army.mil/news/bulletins/default.asp.

Check out the new name of the Center and its reorganization in the articles, "From the Chief," and "Highlights of the Joint Meeting of EWG/FTAG/FWG." The Center is ramping up on the Year 2000 Symposium and Exposition. Dates, place, and POC information are announced in this issue of the Bulletin.

From the field, Dr. Michael McNerney reports on the "Use of GIS and CADD at U.S. Airports." Similar to the DOD, the FAA has experienced growth and implementation challenges with CADD/GIS adoption. Another in-depth article on system design for GIS, "An Inter-Service Approach to GIS Configuration and Development," describes the network server configuration, workstation system variables, and file structure for the root, tools, and data Spatial Data Standards (SDS) directories.

Tech transfer for the latest Center products can be found in these articles: "SDS and FMS-Release 1.80 Year 2000 Compliance Statement," "SDS Toolbox," "Training News," "Natural and Cultural Resources Forum," and "CADD/GIS News." If you have any questions or comments, please contact Center POC's.

Call for Articles – The Center is requesting articles from the field on CADD/GIS/FM projects and their latest applications. The next bulletin is scheduled for January 2000. Submitted articles are due by 1 December 1999. Please e-mail articles or inquiries to Lee Byrne at byrnel@wes.army.mil or call Lee.

POC's: Laurel Gorman, CEERD-ID, 601-634-4484, and Lee Byrne, CEERD-IM-V, 601-634-3729

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New Web Site for CADD/GIS Technology Center

The CADD/GIS Technology Center for Facilities, Infrastructure, and Environment has updated their web site. It is now much easier to find items of interest. Check it out at http://tsc.wes.army.mil. Also, the descriptions of the FY2000 active projects are now available for viewing.

POC: Jean McGinn, CEMP-EE, 202-761-1052

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Architect-Engineer Responsibility Management Program (AERMP)

Reminder: The FY99 AERMP report for MSC's and Centers must be submitted to CEMP-EC (Attn: Don Evick) by 30 November 1999. See paragraph 7-9 of EP 715-1-7, A-E Contracting, for the instructions and Appendix Z for the forms (May 1999 edition). The report consists of a brief cover memorandum summarizing the status and effectiveness of the AERMP in the command and the annual ENG Form 4858-R for each subordinate district or for the center. Make sure the reports include investigation and recovery costs, which are part of the total assessable damages. It is also important to track investigation and recovery costs as a measure of the effectiveness of the AERMP in each command. We will publish a summary of the FY99 AERMP data in the January 2000 newsletter.

POC: Don Evick, CEMP-EC, 202-761-1053

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Dam Safety

ICODS Technical Seminar No.7, Spillway Gates – An Important Aspect of Dam Safety

The Interagency Committee on Dam Safety (ICODS) will present its Technical Seminar No.7, Spillway Gates – An Important Aspect of Dam Safety at the Emergency Management Institute (EMI) in Emmittsburg, Maryland on February 23-25, 2000. This seminar will provide the latest information

about spillway gate and operating equipment inspection, analysis, remediation and operation and maintenance. It will bring together experts from the Corps, Bureau of Reclamation, TVA, FERC, and private practice, Federal and State regulators, and private owners and operators for what promises to be a most comprehensive seminar on spillway gates. Individual presentations will be complimented by panel discussions where the audience will have the opportunity interact with recognized gate experts to pursue innovative ideas and concepts. Low cost accommodations are provided by the EMI and there is no charge for tuition. Additional information can be found at http://www.fema.gov/emi/dsts.htm.

POC: ROBERT BANK, CECW-EP, 202-761-1660

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Information

SURVEY OF LOCKS AND DAMS MECHANICAL AND ELECTRICAL EQUIPMENT FAILURES

The Rock Island District (CEMVR) to gather information on mechanical and electrical equipment failures at civil works locks and dams facilities has set up a website. The CEMVR is assisting the HQUSACE to assemble a failure rate database that can be used for future application to reliability studies. A statistical reliability analysis together with an economic analysis are required to justify the need for any future major rehabilitation work at the Corps hydropower, locks, and dams facilities.

The survey is set up so that it can be filled out easily on the Internet. For security reason, users must initially register by logging in and setting up their passwords. The first time the survey is entered, an user should enter the preliminary information such as his name, Email address, facility name, location, and type of equipment, however he only has to do this once. Any time he re-enters the website for additional data entries, the preliminary information that he entered previously will be shown on the screen. The information that is entered is submitted to a database that can also be queried to find information by many different index searches i.e. search by lock facility or equipment.

You may peruse the website at http://www.mvr.usace.army.mil/failuredata/. The navigation districts/locks should be notified that it is ready for their entries. Lockmasters, mechanics, electricians, and maintenance personnel are welcome and should be encouraged to use it. We ask that they be as accurate as possible. This may require reviewing maintenance records, invoices, logbooks, and in some cases just memory. A similar message has been sent through the civil works O&M contacts to encourage field people to participate. The Bureau of Reclamation has also been notified and welcome to participate. Any questions should be directed to Messrs. Jim Bartek, CEMVR-ED-DG (309-794-5599) or Bryan Radtke (309-794-5598).

POC: ANDY WU, CECW-ET, 202-761-8614

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ADDRESSABLE FIRE ALARM SYSTEMS IN DORMITORIES/HOTELS

The standard practice of connecting single station smoke detectors to the building power in Army dormitories needs to be reviewed and revised because of new power backup requirements of NFPA 72, 2-3.1.2 and audibility requirements of the occupant notification appliances, NFPA 72, 2-4.4.1 & 6-3.2.2. Addressable fire alarm systems with addressable multiple/single station smoke detectors with sounder bases have been more beneficial, effective and economical than the 120V smoke detectors.

The tedious and expensive annual task of replacing the numerous batteries of each smoke detector is eliminated because the fire alarm panel battery provides the secondary power supply. The number of occupant notification appliances in the corridors and outside of the sleeping units is minimized. Both

minimum audibility requirements in sleeping room are provided by programming the addressable fire alarm panel to sound the integral smoke detector sounder bases in the event smoke is detected within the sleeping room/unit or in the event a general alarm is activated through sprinkler water flow or manual pull station activation.

The addressable fire alarm system automatically identifies detectors that need to be cleaned, supervises detector removal/malfunction, keeps a detail record of detectors going into alarm, and allows adjustment of smoke detectors sensitivity to reduce unwanted false alarms. The amount of time/cost is reduced considerably to locate and repair removed or malfunctioning smoke detectors. The addressable system provides a unique address for each initiation device and is able to identify the problem device immediately. Hardwired zoned fire alarm systems can only identify the problem circuit and the maintenance person must spend additional time to find which device is malfunctioning.

POC: MICHAEL YATSUSHIRO, CEPOH-EC-D, 808-438-7055

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HEATER: A COMPREHENSIVE ANALYSIS TOOL FOR HEAT DISTRIBUTION SYSTEMS

The heat distribution systems (HDS's) at many Army installations are aging, deteriorated, and inefficient. Directorates of Public Works (DPW's) have four basic choices for dealing with HDS problems: (1) continue to repair the system as it breaks, (2) modernize or upgrade it, (3) close it and convert to a decentralized system, or (4) privatize it. Making the decision that will best meet the Army's needs requires a very careful engineering and economic evaluation of each potential alternative.

The HEATER software package developed at ERDC@CERL provides a wealth of capabilities to help DPW's make these difficult decisions. HEATER works together with Washington State University's HeatMap program to provide comprehensive HDS analysis. Together, the programs provide the following capabilities:

- Organizes and stores a complete system inventory (including maps)
- Provides quantitative, engineering-based methods for accurately assessing system condition
- Flags areas of high heat loss
- Calculates pressures, flows, temperatures, and heat losses for every pipe in the system
- Predicts future condition of the system
- Predicts remaining system life
- Identifies areas that need repair, rehab, or replacement
- Calculates life cycle costs of alternatives
- Provides an organized framework and quality control tool for maintenance done by contractors
- Allows users to easily model and analyze various scenarios

HEATER can be especially helpful in privatization negotiations. The system inventory allows users to determine the total linear footage and age of various types and diameters of piping quickly and easily. Knowledge of the system's condition and expected life on a quantitative scale can help ensure that the Army receives a fair price for the system. The ability to accurately model system flows and pressures in various scenarios will help ensure that the Army's heating needs are fully met by the third party provider.

In addition to its interface with HeatMap, HEATER can share data with the Cathodic Protection (CP) Diagnostic program so that cathodically protected HDS's can be analyzed.

HEATER has been beta tested at Ft. Jackson. Several modifications and improvements are being made as a result of the beta test. The system will be ready for implementation in February 2000. An improved interface between HEATER and HeatMap will be completed in late FY 2000.

POC: VICKI VAN BLARICUM, CEERD-CF-M, 217-373-6771
AND JOHN LANZARONE, CEMP-ET, 202-761-8634

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CONSTRUCTION PHASE SERVICES

We still see the term "Title II" used in some USACE communications although CEMP-ES memorandum dated 21 May 1996 (copy posted at http://www.hq.usace.army.mil/cemp/C/title2.pdf) directed that this term no longer be used. "Title II" has no statutory or regulatory basis, and has different meanings to various agencies, customers and A-E firms. Instead of "Title II", the referenced memorandum instructed that the term "construction phase services" be used, which is consistent with language in the Brooks Architect-Engineer Act. "Construction phase services" is not as easy to say as "Title II" but it is a much more descriptive term. Try it – you'll like it.

POC: DON EVICK, CEMP-EC, 202-761-1053

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OPERATIONS MANAGEMENT TOOLS FOR CIVIL WORKS

The Operations Division of the Directorate of Civil Works sponsors the development of decision-support tools to help managers prioritize work packages from different business areas (e.g., navigation and hydropower) which ultimately compete for the same Operations and Maintenance (O&M) funding. These tools are designed to provide a quantitative basis for assessing the consequences of deferred maintenance and identifying the minimum funding levels needed by the USACE to operate and maintain its civil infrastructure.

Some of these tools provide decision support in the form of a *condition index* (CI) — a numeric indicator of a structure's physical deterioration and functionality. A CI may range from 0 to 100 as calculated using inspection data collected according to regimented procedures that are objective and repeatable. The Civil Works O&M program requires that CI's be included in certain O&M work-package documentation (inland navigation, breakwaters and jetties, and hydropower) submitted for the annual O&M budget.

To understand how a CI is developed and used, consider the example of a District whose mission includes inland navigation. This District's primary navigation infrastructure components would be steel gates (usually miter, sector, tainter, roller, or lift), valves (tainter, butterfly, sluice), operating equipment for the gates (exposed gears, enclosed gears, gear racks, strut arms, rocker arms, cables, chains, hydraulic cylinders, and couplings), concrete (dams, retaining walls, guidewalls and lock chambers), steel sheet pile structures (retaining walls, locks, mooring cells, cofferdams), and rubble dikes and revetments. Every component will degrade at varying rates according to a multitude of variables, but the complexity of inspecting and tracking the condition of all these components is made more manageable through the specified CI inspection procedures. When inspectors follow the observation and rating criteria, the inspection data can be compiled into a numerical condition index that reliably represents the physical deterioration and functionality of each component. Although some subjectivity may affect certain inspection criteria that are measured by perception rather than instruments (e.g., the sound of a gear train), a follow-up inspection of the same structure by different people will uniformly yield results that are in very close agreement with the first inspection. Districts that have successfully implemented CI systems report three immediate, direct benefits:

1. The systematic, checklist-based approach to condition inspection provides a consistent and repeatable method of establishing benchmarks from which comparisons can be made, trends can be identified, and damage can be reliably quantified.

2. The procedures keep engineers and O&M personnel "up close and personal" with their infrastructure as it operates under everyday conditions (as opposed to the abnormal conditions that prevail during an inspection forced by an equipment failure).

3. Dangerous conditions such as accelerated wear are much more likely to be observed and measured in a timely manner, enabling Districts to correct the problems in advance for a fraction of the cost of recovering from a future equipment failure.

These CI systems also offer an important indirect benefit to Districts: they provide an excellent process for institutionalizing knowledge about the facility inventory and teaching young engineers their way around a Civil Works project.

Rock Island, St Paul, and Tulsa Districts (among others) have been aggressively pursuing innovative ways to integrate CI inspections and data into overall project management to extend cost savings and process improvements. Rock Island has developed a Standard Operating Procedure for CI inspections, all performed by a specially trained in-house team, to be completed immediately before scheduled Periodic Inspections. The data (for miter gates, operating equipment, and concrete) are to be included in the pre-Periodic Inspection brochure and permanently stored as part of the Periodic Inspection report. St. Paul District is very close to completing its initiative to benchmark all of its Mississippi River locks and dams (miter gates, operating equipment, concrete, and some tainter gates), and is already realizing benefits. For example, damage from a barge-gate impact was quantified by comparing current measurements with data collected 2 years earlier. Tulsa District is now looking at broad-scope application of CI systems across diverse business areas including navigation, flood damage reduction, recreation, and hydropower. Other Districts are making significant contributions to CI deployment as well, but space limitations prevent further discussion here.

Work to refine existing CI systems and develop new ones has been funded for FY00. Research and development also continues on tools for modeling Civil Works project performance. Classroom and field training services are available on a reimbursable basis through CERL, District Offices, or private-sector contractors. Such training is valuable not only for District Operations and Engineering personnel who execute the CI inspections, but also for first-line supervisors, Division-level managers, and HQ proponents. For more information about CI applications and available training, contact the POC listed below.

POC: DAVID MCKAY, CEERD-CF-F, 217-352-6511

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Architect's Forum

FUTURE EDITIONS OF THE USACE ARCHITECT'S FORUM SECTION

Future editions of the Architect's Forum will include profiles of USACE architects, a "Where are they Now?" series, examples of successful projects; new about Interior Designers and Landscape Architects, etc. Your participation is absolutely essential. Send your ideas, recommendations and proposed articles to lawrence.p.delaney@usace.army.mil or contact Denise Massihi (CEMP-EC) at 202-761-1380 or Charles Pearre (CECW-EP) at 202-761-4531 for additional information.

POC: LAWRENCE P. DELANEY, AIA, CEMP-E, 202-761-1545

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ENGINEERING & CONSTRUCTION RELATED COURSES—FY2000

The following table shows the FY2000 training agent PROSPECT courses in engineering and construction related fields. If interested in enrolling in any of these courses, you will need to obtain the DD Form 1556, Request for Training, and have it submitted through your local training office to the Registrar's Office in Huntsville, AL.

Additional information on these courses can be found in the FY2000 Purple Book (CEHRP 350-1-1) or online at: http://www.hnd.usace.army.mil/to/pindedx.htm. The point of contact can be reached by e-mail at John.P.Buckley@HND01.usace.army.mil.

Ctl No	Course Title	City	State	Start Date	End Date	Tuition
394	ADV STREAMBANK PROT	VICKSBURG	MS	10-Apr-00	14-Apr-00	$1,990
67	ADVANCED HEC-RAS	DAVIS	CA	24-Jan-00	28-Jan-00	$1,940
178	BASIC HEC-HMS	VICKSBURG	CA	8-May-00	12-May-00	$1,790
13	COASTAL ENGINEER	VICKSBURG	MS	1-Feb-00	10-Feb-00	$2,490
19	COMPUTER APPL/ENGR	VICKSBURG	MS	24-Jan-00	28-Jan-00	$2,020
21	CONCRETE 1--QV	VICKSBURG	MS	31-Jan-00	4-Feb-00	$930
257	CONCRETE MAINT & REP	VICKSBURG	MS	10-Apr-00	14-Apr-00	$1,240
257	CONCRETE MAINT & REP	VICKSBURG	MS	15-May-00	19-May-00	$1,240
22	CONCRETE TECHNOLOGY	VICKSBURG	MS	27-Mar-00	31-Mar-00	$1,540
28	DAM SAFETY	VICKSBURG	MS	13-Mar-00	16-Mar-00	$1,570
28	DAM SAFETY	VICKSBURG	MS	8-May-00	11-May-00	$1,570
40	EARTHWORK --QV	VICKSBURG	MS	24-Jan-00	28-Jan-00	$1,090
275	ENG/DES CONST WETLND	ORLANDO	FL	6-Mar-00	10-Mar-00	$2,250
396	FLOOD CONT CHAN DES	VICKSBURG	MS	15-Nov-99	19-Nov-99	$1,690
219	GIS-HYDROLOGIC ENGR	DAVIS	CA	13-Mar-00	17-Mar-00	$1,740
85	PAVE DESIGN & CONST	VICKSBURG	MS	29-Feb-00	9-Mar-00	$1,410
400	PAVEMENT CONST--QV	VICKSBURG	MS	25-Jan-00	3-Feb-00	$1,450
115	PAVEMENT EVAL/REPAIR	VICKSBURG	MS	28-Mar-00	6-Apr-00	$1,340
125	PAVEMENT MAINT TECH	VICKSBURG	MS	15-Nov-99	19-Nov-99	$1,100
98	RESERVOIR ANALYSIS	DAVIS	CA	19-Jun-00	23-Jun-00	$1,840
161	RIVER & WETLANDS	DAVIS	CA	11-Sep-00	15-Sep-00	$1,870
247	SEISMIC STABILITY	VICKSBURG	MS	12-Jun-00	16-Jun-00	$1,410
113	SOIL STRUC INTERACT	VICKSBURG	MS	20-Mar-00	24-Mar-00	$2,050
285	STREAMBANK EROS/PROT	VICKSBURG	MS	27-Mar-00	31-Mar-00	$1,960
164	WATER & WATERSHED	DAVIS	CA	17-Jul-00	21-Jul-00	$1,700
261	WATERSHED WORK	BALTIMORE	MD	21-Aug-00	25-Aug-00	$950

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A/E/C CADD STANDARDS WORKSPACE TRAINING FOR USERS

The three scheduled training classes developed for Corps users on the MicroStation A/E/C CADD Standards Workspace have been completed. Development of the training materials and conducting the three training classes by Bentley Systems was paid for using Select credits, donated by several districts, which are earned as part of their maintenance agreement with Bentley. A total of 33 persons

were trained. Draft copies of the manuals developed for these courses are available in pdf format on the Corps CADD Web site at http://ckb.wes.army.mil.

POC: JEAN MCGINN, CEMP-EE, 22-761-1052

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Open Discussion and Comments

None received for this month's issue.

(Editors' note: If you want to share your thoughts with our readers regarding a subject of general interest, send an email to the E&C News editors (charles.pearre@usace.army.mil or denise.massihi@usace.army.mil). We'll publish a synopsis of your comments next time).

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Editors' Notes

SUBSCRIBE TO ECNEWS

With this issue of the Engineering and Construction News we have established a subscription list on the Corps List Server. The name of the list is LS-ECNEWS. The purpose of the list is to distribute the Civil Works and Military Programs Engineering and Construction community newsletter, *Engineering and Construction News*.

All the names in address list for the June issue of the news were used to create the subscription list. You can subscribe or unsubscribe to LS-ECNEWS by sending an e-mail message to majordomo@usace.army.mil with no subject line and only a single line of text in the message body. That single line of text should have the following format: **subscribe ls-ecnews** or **unsubscribe ls-ecnews**. The List Server system will automatically pick up your originating e-mail address from the message and add it to or delete it from the distribution list.

If you have any questions about the list server, see the List Server E-Mail Delivery System web page at http://eml01.usace.army.mil/other/listserv.html. Or you may contact either Denise Massihi or Charles Pearre if you have additional questions on the subscription list.

POC: CHARLES PEARRE, CECW-EP, 202-761-4531

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